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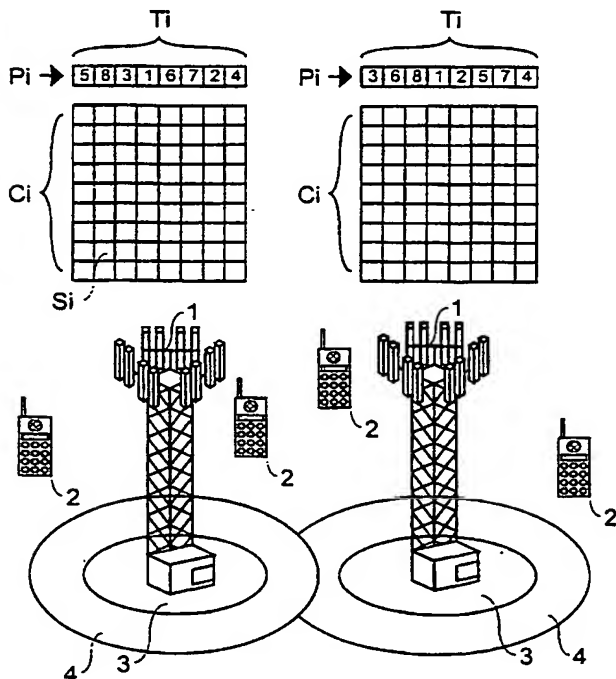
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(54) Title: METHOD AND SYSTEM FOR DYNAMIC ALLOCATION OF RADIO CHANNELS IN DIGITAL TELECOMMUNICATION NETWORKS



(57) Abstract: Method for the dynamic allocation of radio channels (Ci) in digital telecommunication networks with time division duplex access, whose radio signals are divided into frames having pre-determined duration and each frame is subdivided into a pre-determined number of time intervals (Ti) which are assigned priority values (Pi) based on measures of channel interference and/or quality (Ci), each communication service (Sx) employing a particular number (Rx) of said channels (Ci) at a time. This method includes at least a measurement of the signal attenuation (PLx) with which said communication service (Sx) has been requested, as well as the allocation of said number (Rx) of channels (Ci) of the communication service (Sx) in a time interval (Tx) having an increasing priority value (Pi) with the attenuation (PLx) of the relevant signal, in order that the services employing said number (Rx) of channels (Ci) are allocated in time intervals (Ti) having increasing priority values (Pi) with the attenuation of the relevant signal.

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Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal		
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Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 98 59517 A (TELEFONAKTIEBOLAGET LM ERICSSON) 30 December 1998 (1998-12-30) page 3, line 23 -page 9, line 22 ---	1,12
A	EP 0 876 008 A (SIEMENS AKTIENGESELLSCHAFT) 4 November 1998 (1998-11-04) column 3, line 7 - line 15 column 4, line 51 -column 5, line 37 column 6, line 42 - line 58 ---	1,12
A	WO 98 24258 A (TELEFONAKTIEBOLAGET LM ERICSSON) 4 June 1998 (1998-06-04) page 16, line 21 -page 27, line 21 -----	1,12
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<div style="display: flex;"> <div style="flex: 1;"> <p>* Special categories of cited documents :</p> <p>*A* document defining the general state of the art which is not considered to be of particular relevance</p> <p>*E* earlier document but published on or after the international filing date</p> <p>*L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>*O* document referring to an oral disclosure, use, exhibition or other means</p> <p>*P* document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="flex: 1;"> <p>*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>*G* document member of the same patent family</p> </div> </div>		
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METHOD AND SYSTEM FOR DYNAMIC ALLOCATION OF RADIO CHANNELS IN DIGITAL TELECOMMUNICATION NETWORKS

5 Field of the Invention

The present invention relates to a method for the dynamic allocation of radio channels in digital telecommunication networks, in particular with time division duplex access or TDD (*Time Division Duplex*), such as for instance mobile telecommunication networks belonging to DECT or UTMS-TDD standards. The present invention relates also to a system implementing this method.

10 It is well known that in mobile telecommunication networks with TDD access, the transmission and reception of radio signals from and to the base stations do not occur at the same time, but are alternated in a continuous sequence of periods having pre-determined duration, each of them called *frame* and opportunely coded and identified
15 by the system. In particular, each frame is divided into a pre-determined number of time intervals or *timeslots*, they too having pre-determined duration, part of which is destined to transmission and part to the reception of the signals from base station to user equipment. Each one of these timeslots can also be subdivided into a plurality of *codes* representing the elementary resources (channels) assigned in the
20 communication.

At each communication service between a mobile unit and a base station one or more channels of a particular time slot are generally assigned, which contains at most N_{max} channels, according to the requested transmission speed.

Background art

25 The selection of said timeslot is made through a dynamic channel allocation procedure based on priority values P_i calculated for each timeslot. In this procedure disclosed in the article by Y. Furuya and Y. Akaiwa under the title "Channel Segregation, A distributed Adaptive Channel Allocation Scheme for Mobile Communication Systems", Second Nordic Seminar on digital Land Mobile Radio
30 Communication, 14-16 October 1986", pp 311-315, the control processor of the base station performs at each service request, a calculation of the priority values P_i on the basis of interference and/or quality measures of the channels, so that the timeslots available for the allocation of channels result only those whose priority value is higher than a given pre-set threshold value P_t . The calculation of priority values P_i of each

timeslot after k service requests is generally made through the following iterative formula:

$$Pi(k) = \frac{Ns_i(k)}{k} = \frac{\sum_{a=1}^k s_i(a)}{k} = \frac{k-1}{k} Pi(k-1) + \frac{s_i(k)}{k};$$

5 where k is the number of connection service requests from the moment of system starting, $Ns_i(k)$ is the number of successful connections and $s_i(k)$ is a logic function returning 0 or 1 on the basis of the negative or positive result of the connection, respectively.

Observing such formula, it can be noticed that at starting, with small k values, the calculation of priority values very quickly adapts to the network characteristics, but
10 results slowed when k values increase, therefore the above mentioned method known for the allocation of channels shows a high risk for connection losses in case the network traffic distribution suddenly changes, for instance when number of connection service requests occur, concentrated in time.

Summary and scope of the Invention

15 Object of the present invention is therefore that to give a method for the dynamic allocation of channels which is free from this drawback, as well as a system implementing this method. Said object is attained with a method and a system whose main characteristics are specified in claims 1 and 12, respectively, while additional characteristics which are believed to be novel are specified in the appended claims.

20 The method according to the present invention results much more rapid than the known methods, since a partial re-ordering of channels allocated in the different timeslots is made, that is, at each service requests, only the services employing the same number of channels of the requested service are re-ordered.

Moreover, the quality of channels allocated through the method according to the
25 present invention is generally bettered compared to that of the channels allocated through the known methods. In fact, at equal number of allocated channels, the services with signals having high attenuation values or *pathloss* are allocated in timeslots having high priority values, so that the allocated channels can be shared in the different timeslots in the best way according to the quality of the relevant signals.

30 Another advantage of the method according to the present invention is represented by the use of a new kind of formula for the calculation of priority values which, contrarily to the above mentioned formula of the known type, enables to

discretionary adjust the system adaptation speed to the contingent situation of the network traffic, that is to the interference and/or quality variations of the channels.

A further advantage of the method according to the present invention is represented by the fact that said allocation and release algorithms can be structured in such a way to give preference, if necessary, to the services employing a low or high number of channels.

Brief description of figures

The present invention together with further advantages and characteristics thereof may be understood by those skilled in the art making reference to the following detailed description taken in conjunction with the accompanying drawings in which:

- figure 1 shows a partial block diagram of a system implementing the method according to the present invention;
- figure 2 shows a flow chart of an allocation algorithm of an embodiment of the method according to the present invention; and
- figure 3 shows a flow chart of a release algorithm of an embodiment of the method according to the present invention.

Detailed description of a preferred embodiment of the Invention

Making reference to figure 1, it can be noticed that a system implementing the method according to the present invention includes in a known way, a plurality of base stations 1 belonging to a digital telecommunication network with time division duplex access, such as for instance a mobile telecommunication network belonging to the UTMS standard, which communicate through radio signals with a plurality of user equipment 2. One or more channels C_i of a timeslot T_i are generally assigned to each communication service S_i made by base stations 1 (only 8 timeslots T_i of communications originated by the user equipment 2 are shown in the figure, for representation simplicity). Furthermore, a univocal priority value P_i is assigned to each timeslot T_i which, however, can vary in time according to the result of a known formula of the type described above or of a new formula which shall be described here after. Said priority values P_i are based on interference and/or quality measures of communication channels C_i between base stations 1 and user equipment 2.

According to a preferred embodiment of the invention the interference and/or quality measures of channels are made measuring the "path loss", that is the attenuation of the signal transmitted by the user equipment 2. According to the invention, the communications with higher path loss are allocated in timeslots with

higher priority P_i , that is in channels capable of ensuring a better transmission quality. On the contrary, communications with lower "path loss" are allocated in timeslots with lower priority P_i , that is in channels capable of ensuring a lower quality.

Tentatively said situation has been represented in figure 1 where for each station
5 1 a first coverage area 3 and a second coverage area 4 are represented. In figure 1 it is assumed that users located in the coverage area 4 are more distant from the relevant base station 1 and therefore communications shall be reasonably characterised by a higher "path loss" (they shall therefore be assigned a timeslot having higher priority P_i), while the users in coverage area 3 are closer to the relevant
10 base station 1 and therefore their communications shall be reasonably characterised by a lower "path loss" (they shall therefore be assigned a timeslot having lower priority P_i).

Now, making reference also to figure 2, we notice that an embodiment of the method according to the present invention includes an allocation algorithm, which is
15 started for instance on the moment a mobile unit 2 requests a service S_x requiring the use of a given number R_x of channels C_i to a base station 1. The base station 1 measures the level and therefore the path loss PL_x of the signal with which the mobile unit 2 has requested said service S_x on the receipt channel. On the basis of the path loss measured value PL_x , the base station 1 attempts to allocate the R_x channels C_i in
20 the timeslot having an increasing priority value P_i with the same attenuation PL_x , in order that user equipment 2 transmitting signals having a high path loss use timeslots having a high priority value.

To this purpose, it is searched, starting from timeslots having higher priority values P_i , a timeslot T_x having R_x free channels C_i . If said timeslot T_x does not exist,
25 the base station 1 refuses the requested service S_x to the mobile unit 2. If on the contrary said timeslot T_x is found, the base station 1 searches, if existing, a timeslot where at least a service employing R_x channels C_i is allocated among the timeslots with priority value P_i higher than that of the timeslot T_x . This search is made through a scanning based on a variable T cyclically decreased by one unit. If the variable T is
30 zeroed, the requested service S_x is allocated in the timeslot T_x . If on the contrary a timeslot T is found where at least a service with R_x channels C_i is allocated a search is made among all the services employing R_x channels C_i and are in the same timeslot T , the service S_y showing the lower path loss PL_m . At this point, the base station 1 compares the value of the lower path loss PL_m found with that of the PL_x path loss of

the signal with which the mobile unit 2 has requested the service S_x to base station 1. If the PL_x path loss value is lower than that of the PL_m path loss, the requested service S_x is allocated in the timeslot T_x having Rx free channels C_i , otherwise it is allocated in the same the service S_y employing Rx channels C_i and showing the PL_m path loss. In this last case, since a service having Rx channels C_i in the timeslot T got free, the algorithm described up to now is reiterated starting from this last timeslot, which is then identified as timeslot T_x in the reiteration of the algorithm itself, that is $T_x = T$.

When the service S_x is released, for instance after the interruption of a communication between mobile unit 2 and base station 1 or due to the transfer of a communication between two base stations 1, it is possible to employ a release algorithm of essentially inverse type compared to the one described above to free the timeslots T_i with low priority values P_i .

Making reference to figure 3, we see that an embodiment of the method according to the present invention includes a release algorithm, which is started for instance on the moment at which a service S_x employing Rx channels C_i is released by a timeslot T_x . The base station 1 attempts therefore to allocate the Rx free channels C_i to a service S_y employing Rx channels C_i in the timeslot having the highest priority value P_i among those having lower priority value compared to that of the timeslot T_x . To this purpose, the base station 1 searches, if existing, a timeslot where at least a service employing Rx channels C_i is allocated, among the timeslots with priority value P_i lower than that of the timeslot T_x . This search is made through a scanning based on a variable T cyclically decreased by one unit. If said timeslot T is found, the service S_y characterised by the highest path loss amongst all the services employing Rx channels C_i in timeslot T is allocated in the timeslot T_x . In this last case, since a service having Rx channels C_i in the timeslot T has got free, the algorithm described up to now is reiterated starting from this last timeslot, which is then identified as timeslot T_x in the reiteration of the algorithm itself, that is $T_x = T$.

If the variable T is reset, the search can be terminated or, a service S_y employing a number of channels C_i lower than Rx newly searched among all the timeslots with a priority value P_i lower than that of the last timeslot T_x released. Said research is made through an additional scanning based on a variable R cyclically decreased by one unit. Once this last variable is reset, the algorithm is terminated.

Other embodiments of the method according to the present invention can possibly include variants of said release algorithm, always started on the moment on

which a service S_x employing R_x channels C_i is released by a timeslot T_x . For instance, instead of searching first the services S_y employing R_x channels C_i among all the timeslots having a priority value P_i lower than that of the timeslot T_x , to pass then to the search of services S_y employing a number of channels C_i lower than R_x always
 5 among all the same timeslots, it is possible to search the service S_y characterised by the maximum attenuation employing a number of channels C_i equal to or even lower than R_x in all the timeslots having lower priority value P_i compared to that of the timeslot T_x . With this algorithm, active services can therefore be reordered according to PLx attenuation values and increasing priority P_i values, irrespective of the number of
 10 channels C_i they employ.

At each allocation and/or release of a service, the priority values P_i assigned to the timeslots T_i can be recalculated. In place of the known algorithm based on the formula

$$P_i(k) = \frac{k-1}{k} P_i(k-1) + \frac{s_i(k)}{k},$$

15 in another embodiment of the method according to the present invention it is possible to employ the following formula in which the past experience $P_i(k-1)$ and the current situation $s_i(k)$ maintain a constant weight during the time:

$$P_i(k) = \lambda P_i(k-1) + (1-\lambda) s_i(k),$$

,where λ is a memory factor included between 0 and 1, which can be freely selected according to the weight one wants to assign to the past experience or to the
 20 contingent situation. It is therefore clear that if λ tends to 0 or to 1, the priority values P_i vary in a quicker or lower way, respectively, depending on the interference and/or quality measures of channels C_i by the base station 1.

A further development of this other embodiment can consist in calculating $s_i(k)$ not on the basis of the simple statistics of the successful connections compared to total
 25 connections, but on the basis of the following formula:

$$s_i(k) = \frac{N_{free_i}(k)}{N_{max} - N_{used_i}(k)};$$

in which $N_{free_i}(k)$ is the number of channels C_i which can be allocated with a good quality in timeslot i , N_{max} is the maximum number of channels (or codes) available per timeslot and $N_{used_i}(k)$ is the number of channels currently already allocated in the
 30 timeslot i .

Other embodiments and/or additions of the present invention may be made by those skilled in the art without departing from the scope thereof.

CLAIMS

1. Method for the dynamic allocation of radio channels (Ci) in digital telecommunication networks with time division duplex access, in which radio signals are divided into frames having a pre-determined duration and each frame is divided into a pre-determined number of timeslots (Ti) which are assigned priority values (Pi) based on interference and/or quality measures of channels (Ci), each communication service (Sx) employing a particular number (Rx) of said channels (Ci) at a time, characterized in that it includes the following operational steps:
 - 5 - measuring the path loss (PLx) of the signal with which said communication service (Sx) has been requested;
 - allocating said number (Rx) of channels (Ci) of the communication service (Sx) in a timeslot (Tx) having a priority value (Pi) increasing with the attenuation (PLx) of the relevant signal, in such a way that the services employing said number (Rx) of channels (Ci) are allocated in timeslots (Ti) having priority values (Pi) increasing with the attenuation of the relevant signal.
2. Method according to the previous claim, characterized in that at each request for a communication service (Sx) the services employing the same number (Rx) of channels (Ci) of the requested service (Sx) are reordered in such a way that the attenuation (PLx) increases with priority values (Pi).
3. Method according to one of the previous claims, characterized in that it includes an allocation algorithm including the following operational steps:
 - 25 - searching, starting from timeslots (Ti) with highest priority values (Pi), a timeslot (Tx) having a number of free channels (Ci) equal to the number (Rx) of channels (Ci) of the requested service (Sx);
 - searching, starting from timeslots with priority values (Pi) higher than that of the timeslot (Tx) found with this search, a communication service (Sy) having the same number (Rx) of allocated channels (Ci);
 - 30 - comparing the path loss values of the signals of the requested communication service (Sx) and of communication service (Sy) found with this search;
 - allocating, according to the result of this comparison, one of these communication services (Sx, Sy) in the timeslot (Tx) having said number (Rx) of free channels (Ci).

4. Method according to the previous claim, characterized in that said algorithm is reiterated according to the result of said comparison between the attenuation values of the signals of the requested communication service (Sx) and of the communication service (Sy) found with this search.
- 5 5. Method according to claim 3 or 4, characterized in that it is searched, starting from timeslots with priority values (Pi) higher than that of the timeslot (Tx) found with this first search, the communication service (Sy) whose signals show the lower attenuation (PLm) among the communication services having the same number (Rx) of channels (Ci) allocated in the same timeslot (Tx).
- 10 6. Method according to one of the previous claims, characterized in that at each release of a communication service (Sx) are reordered according to increasing priority values (Pi) the services employing the same number (Rx) of channels (Ci) of the service released (Sx).
- 15 7. Method according to the previous claim, characterized in that it includes a release algorithm including the following operational steps:
 - searching, among the timeslots with priority values (Pi) lower than that of the timeslot (Tx) of the released service (Sx), a timeslot (T) in which at least a communication service having the same number (Rx) of channels (Ci) of the communication service released (Sx) is allocated;
 - 20 - allocating in the timeslot (Tx) of the released communication service (Sx) the communication service (Sy) characterised by the highest attenuation among all the services employing Rx channels (Ci) in the timeslot (T) found with this research.
- 25 8. Method according to the previous claim, characterized in that it includes a release algorithm including the following additional operational steps:
 - searching, among the timeslots with priority values (Pi) lower than that of the timeslot (Tx) of the released communication service (Sx), a timeslot (T) in which at least a communication service employing a number of channels (Ci) lower than that of the communication service released (Sx) is allocated;
 - 30 - allocating in the timeslot (Tx) of the released communication service (Sx) the communication service (Sy) characterised by a higher attenuation amongst all the services employing a number of channels (Ci) lower than that of the communication service released (Sx) and which are allocated in the timeslot (T) found with this search.

9. Method according to claim 7 or 8, characterised in that said algorithm is reiterated starting from the timeslot of the last communication service released (S_y).

10. Method according to one of the previous claims, characterized in that at each allocation and/or release of a service, the priority values (P_i) assigned to the timeslots (T_i) are re-calculated on the basis of the following formula:

$$P_i(k) = \lambda P_i(k-1) + (1-\lambda) s_i(k),$$

where k is the instant at which the service is allocated or released, $s_i(k)$ is a logic function returning a number between 0 and 1 on the basis of the negative or positive result, respectively, of these requests for connection services and λ is a memory factor included between 0 and 1.

11. Method according to the previous claim, characterized in that $s_i(k)$ is defined by the following formula:

$$s_i(k) = \frac{N_{free_i}(k)}{N_{max} - N_{used_i}(k)};$$

in which $N_{free_i}(k)$ is the number of channels C_i that can be allocated with a good quality in the timeslot i , N_{max} is the maximum number of channels (or codes) available for each timeslot and $N_{used_i}(k)$ is the number of channels presently already allocated in timeslot i .

12. System for the dynamic allocation of radio channels (C_i) in digital telecommunication networks with time division duplex access, in which radio signals are divided in frames having pre-determined duration and each frame is divided into a pre-determined number of timeslots (T_i) which are assigned priority values (P_i) based on interference and/or quality measures of channels (C_i), each communication service (S_x) employing a particular number (R_x) of said channels (C_i) at a time, characterized in that at least one base station (1) for the reception and transmission of radio signals to a plurality of user equipment (2) includes means for the measurement of the path loss (PL_x) of the signal with which said communication service (S_x) has been requested, as well as a control processor suitable to implement the method according to one of the previous claims.

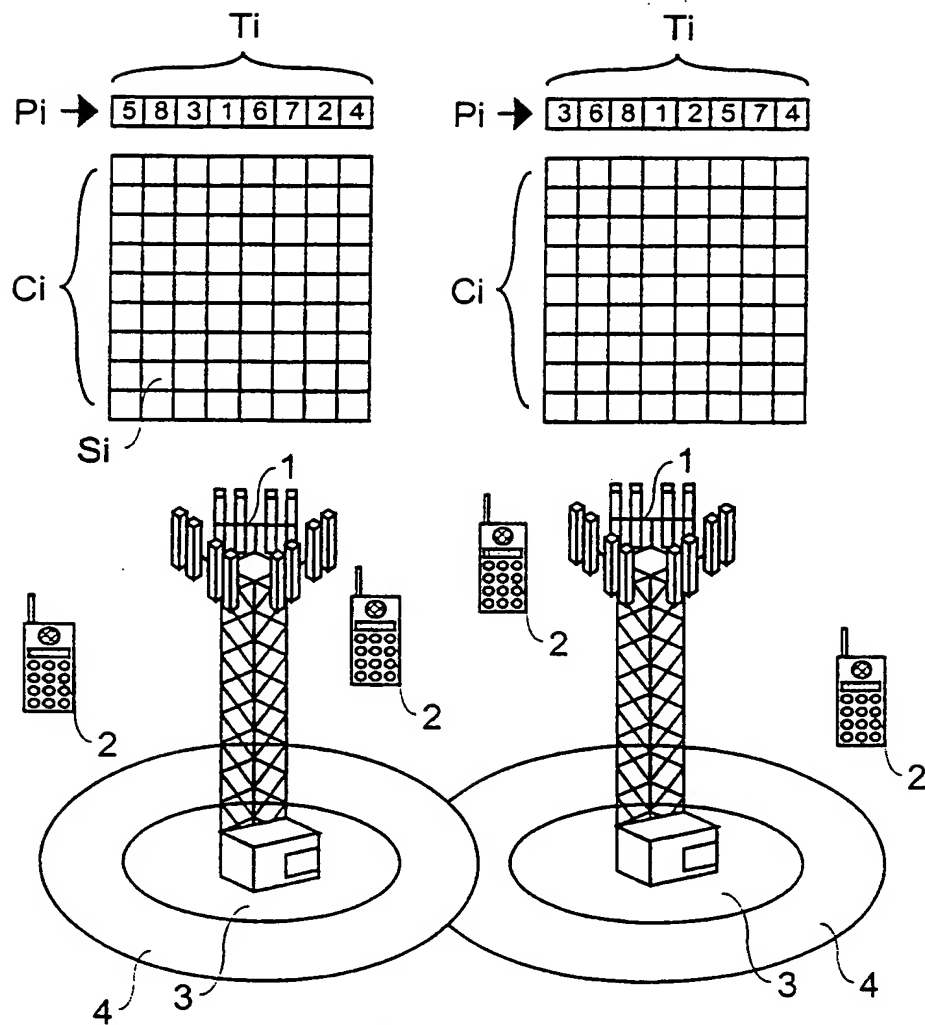
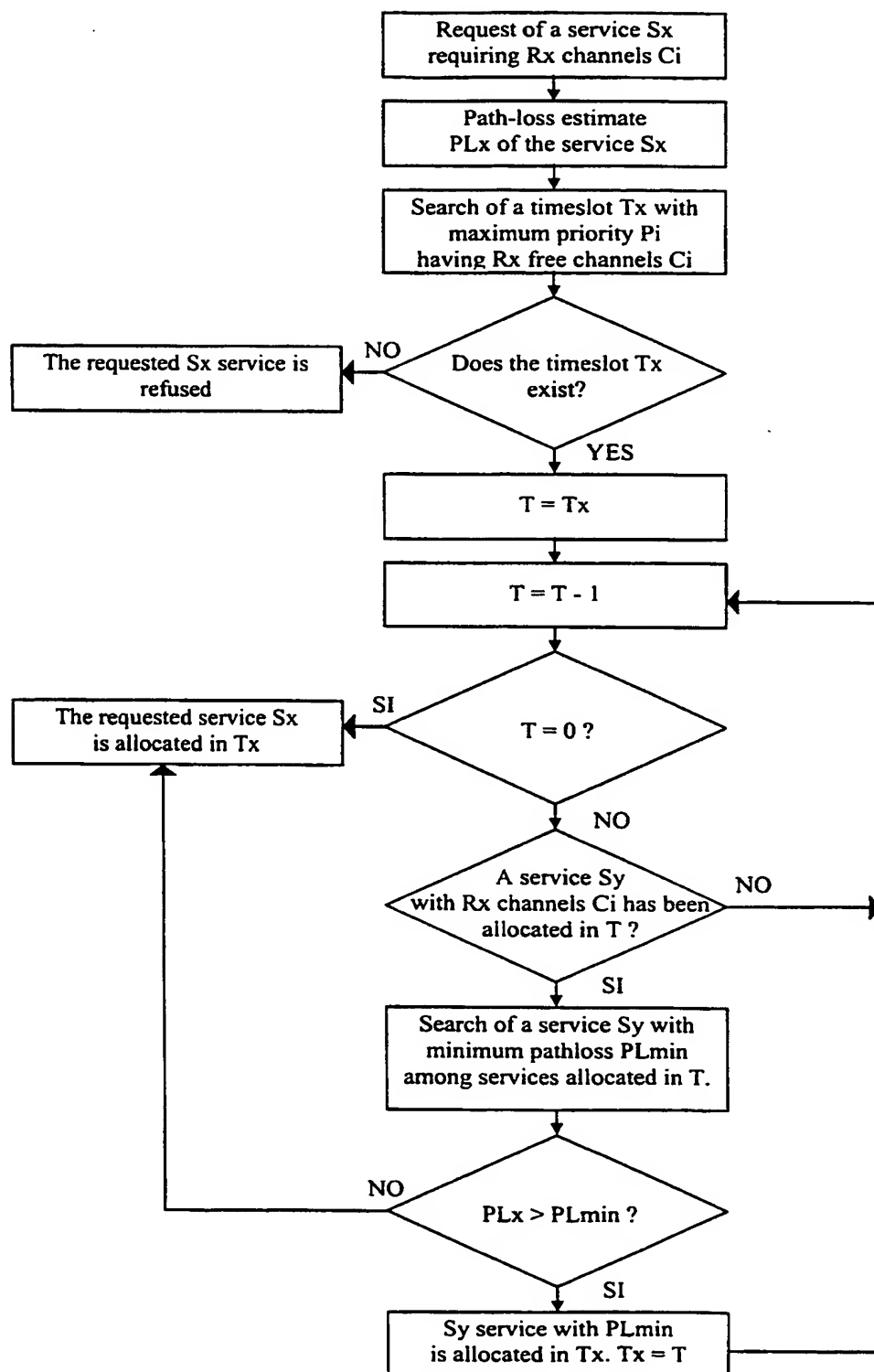
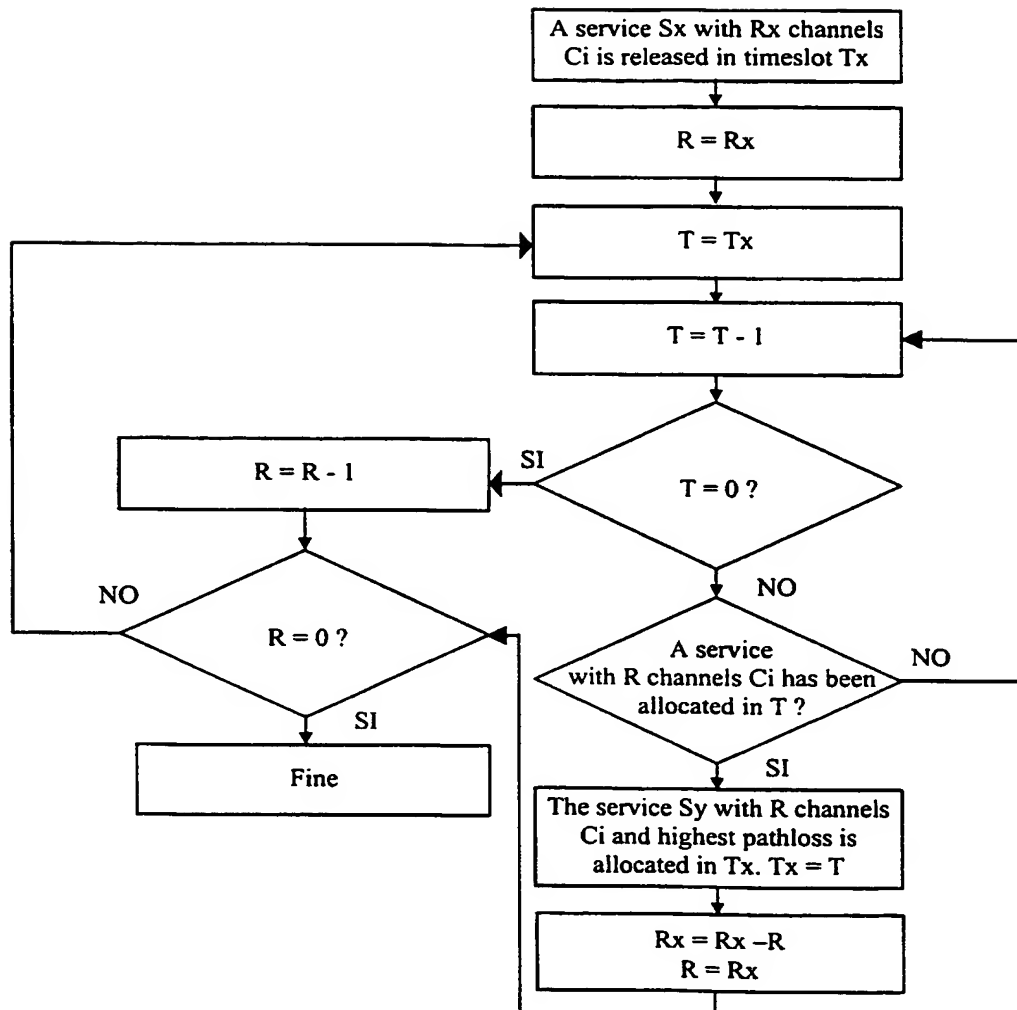


Fig. 1

2/3

*Fig. 2*

**Fig. 3**

METHOD AND SYSTEM FOR DYNAMIC ALLOCATION OF RADIO CHANNELS IN DIGITAL TELECOMMUNICATION NETWORKS

5 Field of the Invention

The present invention relates to a method for the dynamic allocation of radio channels in digital telecommunication networks, in particular with time division duplex access or TDD (*Time Division Duplex*), such as for instance mobile telecommunication networks belonging to DECT or UTMS-TDD standards. The present invention relates also to a system implementing this method.

10 It is well known that in mobile telecommunication networks with TDD access, the transmission and reception of radio signals from and to the base stations do not occur at the same time, but are alternated in a continuous sequence of periods having pre-determined duration, each of them called *frame* and opportunely coded and identified
15 by the system. In particular, each frame is divided into a pre-determined number of time intervals or *timeslots*, they too having pre-determined duration, part of which is destined to transmission and part to the reception of the signals from base station to user equipment. Each one of these timeslots can also be subdivided into a plurality of *codes* representing the elementary resources (channels) assigned in the
20 communication.

At each communication service between a mobile unit and a base station one or more channels of a particular time slot are generally assigned, which contains at most Nmax channels, according to the requested transmission speed.

Background art

25 The selection of said timeslot is made through a dynamic channel allocation procedure based on priority values P_i calculated for each timeslot. In this procedure disclosed in the article by Y. Furuya and Y. Akaiwa under the title "Channel Segregation, A distributed Adaptive Channel Allocation Scheme for Mobile Communication Systems", Second Nordic Seminar on digital Land Mobile Radio
30 Communication, 14-16 October 1986", pp 311-315, the control processor of the base station performs at each service request, a calculation of the priority values P_i on the basis of interference and/or quality measures of the channels, so that the timeslots available for the allocation of channels result only those whose priority value is higher than a given pre-set threshold value P_t . The calculation of priority values P_i of each

timeslot after k service requests is generally made through the following iterative formula:

$$Pi(k) = \frac{Ns_i(k)}{k} = \frac{\sum_{a=1}^k s_i(a)}{k} = \frac{k-1}{k} Pi(k-1) + \frac{s_i(k)}{k};$$

where k is the number of connection service requests from the moment of system starting, $Ns_i(k)$ is the number of successful connections and $s_i(k)$ is a logic function returning 0 or 1 on the basis of the negative or positive result of the connection, respectively.

Observing such formula, it can be noticed that at starting, with small k values, the calculation of priority values very quickly adapts to the network characteristics, but results slowed when k values increase, therefore the above mentioned method known for the allocation of channels shows a high risk for connection losses in case the network traffic distribution suddenly changes, for instance when number of connection service requests occur, concentrated in time.

Summary and scope of the Invention

Object of the present invention is therefore that to give a method for the dynamic allocation of channels which is free from this drawback, as well as a system implementing this method. Said object is attained with a method and a system whose main characteristics are specified in claims 1 and 12, respectively, while additional characteristics which are believed to be novel are specified in the appended claims.

The method according to the present invention results much more rapid than the known methods, since a partial re-ordering of channels allocated in the different timeslots is made, that is, at each service requests, only the services employing the same number of channels of the requested service are re-ordered.

Moreover, the quality of channels allocated through the method according to the present invention is generally bettered compared to that of the channels allocated through the known methods. In fact, at equal number of allocated channels, the services with signals having high attenuation values or *pathloss* are allocated in timeslots having high priority values, so that the allocated channels can be shared in the different timeslots in the best way according to the quality of the relevant signals.

Another advantage of the method according to the present invention is represented by the use of a new kind of formula for the calculation of priority values which, contrarily to the above mentioned formula of the known type, enables to

discretionary adjust the system adaptation speed to the contingent situation of the network traffic, that is to the interference and/or quality variations of the channels.

A further advantage of the method according to the present invention is represented by the fact that said allocation and release algorithms can be structured in such a way to give preference, if necessary, to the services employing a low or high number of channels.

Brief description of figures

The present invention together with further advantages and characteristics thereof may be understood by those skilled in the art making reference to the following detailed description taken in conjunction with the accompanying drawings in which:

- figure 1 shows a partial block diagram of a system implementing the method according to the present invention;
- figure 2 shows a flow chart of an allocation algorithm of an embodiment of the method according to the present invention; and
- figure 3 shows a flow chart of a release algorithm of an embodiment of the method according to the present invention.

Detailed description of a preferred embodiment of the invention

Making reference to figure 1, it can be noticed that a system implementing the method according to the present invention includes in a known way, a plurality of base stations 1 belonging to a digital telecommunication network with time division duplex access, such as for instance a mobile telecommunication network belonging to the UTMS standard, which communicate through radio signals with a plurality of user equipment 2. One or more channels C_i of a timeslot T_i are generally assigned to each communication service S_i made by base stations 1 (only 8 timeslots T_i of communications originated by the user equipment 2 are shown in the figure, for representation simplicity). Furthermore, a univocal priority value P_i is assigned to each timeslot T_i which, however, can vary in time according to the result of a known formula of the type described above or of a new formula which shall be described here after. Said priority values P_i are based on interference and/or quality measures of communication channels C_i between base stations 1 and user equipment 2.

According to a preferred embodiment of the invention the interference and/or quality measures of channels are made measuring the "path loss", that is the attenuation of the signal transmitted by the user equipment 2. According to the invention, the communications with higher path loss are allocated in timeslots with

higher priority P_i , that is in channels capable of ensuring a better transmission quality. On the contrary, communications with lower "path loss" are allocated in timeslots with lower priority P_i , that is in channels capable of ensuring a lower quality.

5 Tentatively said situation has been represented in figure 1 where for each station 1 a first coverage area 3 and a second coverage area 4 are represented. In figure 1 it is assumed that users located in the coverage area 4 are more distant from the relevant base station 1 and therefore communications shall be reasonably characterised by a higher "path loss" (they shall therefore be assigned a timeslot having higher priority P_i), while the users in coverage area 3 are closer to the relevant
10 base station 1 and therefore their communications shall be reasonably characterised by a lower "path loss" (they shall therefore be assigned a timeslot having lower priority P_i).

Now, making reference also to figure 2, we notice that an embodiment of the method according to the present invention includes an allocation algorithm, which is
15 started for instance on the moment a mobile unit 2 requests a service S_x requiring the use of a given number R_x of channels C_i to a base station 1. The base station 1 measures the level and therefore the path loss PL_x of the signal with which the mobile unit 2 has requested said service S_x on the receipt channel. On the basis of the path loss measured value PL_x , the base station 1 attempts to allocate the R_x channels C_i in
20 the timeslot having an increasing priority value P_i with the same attenuation PL_x , in order that user equipment 2 transmitting signals having a high path loss use timeslots having a high priority value.

To this purpose, it is searched, starting from timeslots having higher priority values P_i , a timeslot T_x having R_x free channels C_i . If said timeslot T_x does not exist,
25 the base station 1 refuses the requested service S_x to the mobile unit 2. If on the contrary said timeslot T_x is found, the base station 1 searches, if existing, a timeslot where at least a service employing R_x channels C_i is allocated among the timeslots with priority value P_i higher than that of the timeslot T_x . This search is made through a scanning based on a variable T cyclically decreased by one unit. If the variable T is
30 zeroed, the requested service S_x is allocated in the timeslot T_x . If on the contrary a timeslot T is found where at least a service with R_x channels C_i is allocated a search is made among all the services employing R_x channels C_i and are in the same timeslot T , the service S_y showing the lower path loss PL_m . At this point, the base station 1 compares the value of the lower path loss PL_m found with that of the PL_x path loss of

the signal with which the mobile unit 2 has requested the service S_x to base station 1. If the PL_x path loss value is lower than that of the PL_m path loss, the requested service S_x is allocated in the timeslot T_x having Rx free channels C_i , otherwise it is allocated in the same the service S_y employing Rx channels C_i and showing the PL_m path loss. In this last case, since a service having Rx channels C_i in the timeslot T got free, the algorithm described up to now is reiterated starting from this last timeslot, which is then identified as timeslot T_x in the reiteration of the algorithm itself, that is $T_x = T$.

When the service S_x is released, for instance after the interruption of a communication between mobile unit 2 and base station 1 or due to the transfer of a communication between two base stations 1, it is possible to employ a release algorithm of essentially inverse type compared to the one described above to free the timeslots T_i with low priority values P_i .

Making reference to figure 3, we see that an embodiment of the method according to the present invention includes a release algorithm, which is started for instance on the moment at which a service S_x employing Rx channels C_i is released by a timeslot T_x . The base station 1 attempts therefore to allocate the Rx free channels C_i to a service S_y employing Rx channels C_i in the timeslot having the highest priority value P_i among those having lower priority value compared to that of the timeslot T_x . To this purpose, the base station 1 searches, if existing, a timeslot where at least a service employing Rx channels C_i is allocated, among the timeslots with priority value P_i lower than that of the timeslot T_x . This search is made through a scanning based on a variable T cyclically decreased by one unit. If said timeslot T is found, the service S_y characterised by the highest path loss amongst all the services employing Rx channels C_i in timeslot T is allocated in the timeslot T_x . In this last case, since a service having Rx channels C_i in the timeslot T has got free, the algorithm described up to now is reiterated starting from this last timeslot, which is then identified as timeslot T_x in the reiteration of the algorithm itself, that is $T_x = T$.

If the variable T is reset, the search can be terminated or, a service S_y employing a number of channels C_i lower than R_x newly searched among all the timeslots with a priority value P_i lower than that of the last timeslot T_x released. Said research is made through an additional scanning based on a variable R cyclically decreased by one unit. Once this last variable is reset, the algorithm is terminated.

Other embodiments of the method according to the present invention can possibly include variants of said release algorithm, always started on the moment on

which a service S_x employing R_x channels C_i is released by a timeslot T_x . For instance, instead of searching first the services S_y employing R_x channels C_i among all the timeslots having a priority value P_i lower than that of the timeslot T_x , to pass then to the search of services S_y employing a number of channels C_i lower than R_x always among all the same timeslots, it is possible to search the service S_y characterised by the maximum attenuation employing a number of channels C_i equal to or even lower than R_x in all the timeslots having lower priority value P_i compared to that of the timeslot T_x . With this algorithm, active services can therefore be reordered according to PLx attenuation values and increasing priority P_i values, irrespective of the number of channels C_i they employ.

At each allocation and/or release of a service, the priority values P_i assigned to the timeslots T_i can be recalculated. In place of the known algorithm based on the formula

$$P_i(k) = \frac{k-1}{k} P_i(k-1) + \frac{s_i(k)}{k},$$

in another embodiment of the method according to the present invention it is possible to employ the following formula in which the past experience $P_i(k-1)$ and the current situation $s_i(k)$ maintain a constant weight during the time:

$$P_i(k) = \lambda P_i(k-1) + (1-\lambda)s_i(k),$$

where λ is a memory factor included between 0 and 1, which can be freely selected according to the weight one wants to assign to the past experience or to the contingent situation. It is therefore clear that if λ tends to 0 or to 1, the priority values P_i vary in a quicker or lower way, respectively, depending on the interference and/or quality measures of channels C_i by the base station 1.

A further development of this other embodiment can consist in calculating $s_i(k)$ not on the basis of the simple statistics of the successful connections compared to total connections, but on the basis of the following formula:

$$s_i(k) = \frac{N_{free_i}(k)}{N_{max} - N_{used_i}(k)};$$

in which $N_{free_i}(k)$ is the number of channels C_i which can be allocated with a good quality in timeslot i , N_{max} is the maximum number of channels (or codes) available per timeslot and $N_{used_i}(k)$ is the number of channels currently already allocated in the timeslot i .

Other embodiments and/or additions of the present invention may be made by those skilled in the art without departing from the scope thereof.

CLAIMS

1. Method for the dynamic allocation of radio channels (Ci) in digital telecommunication networks with time division duplex access, in which radio signals are divided into frames having a pre-determined duration and each frame is divided into a pre-determined number of timeslots (Ti) which are assigned priority values (Pi) based on interference and/or quality measures of channels (Ci), each communication service (Sx) employing a particular number (Rx) of said channels (Ci) at a time, characterized in that it includes the following operational steps:
 - measuring the path loss (PLx) of the signal with which said communication service (Sx) has been requested;
 - allocating said number (Rx) of channels (Ci) of the communication service (Sx) in a timeslot (Tx) having a priority value (Pi) increasing with the attenuation (PLx) of the relevant signal, in such a way that the services employing said number (Rx) of channels (Ci) are allocated in timeslots (Ti) having priority values (Pi) increasing with the attenuation of the relevant signal.
2. Method according to the previous claim, characterized in that at each request for a communication service (Sx) the services employing the same number (Rx) of channels (Ci) of the requested service (Sx) are reordered in such a way that the attenuation (PLx) increases with priority values (Pi).
3. Method according to one of the previous claims, characterized in that it includes an allocation algorithm including the following operational steps:
 - searching, starting from timeslots (Ti) with highest priority values (Pi), a timeslot (Tx) having a number of free channels (Ci) equal to the number (Rx) of channels (Ci) of the requested service (Sx);
 - searching, starting from timeslots with priority values (Pi) higher than that of the timeslot (Tx) found with this search, a communication service (Sy) having the same number (Rx) of allocated channels (Ci);
 - comparing the path loss values of the signals of the requested communication service (Sx) and of communication service (Sy) found with this search;
 - allocating, according to the result of this comparison, one of these communication services (Sx, Sy) in the timeslot (Tx) having said number (Rx) of free channels (Ci).

4. Method according to the previous claim, characterized in that said algorithm is reiterated according to the result of said comparison between the attenuation values of the signals of the requested communication service (Sx) and of the communication service (Sy) found with this search.
- 5 5. Method according to claim 3 or 4, characterized in that it is searched, starting from timeslots with priority values (Pi) higher than that of the timeslot (Tx) found with this first search, the communication service (Sy) whose signals show the lower attenuation (PLm) among the communication services having the same number (Rx) of channels (Ci) allocated in the same timeslot (Tx).
- 10 6. Method according to one of the previous claims, characterized in that at each release of a communication service (Sx) are reordered according to increasing priority values (Pi) the services employing the same number (Rx) of channels (Ci) of the service released (Sx).
- 15 7. Method according to the previous claim, characterized in that it includes a release algorithm including the following operational steps:
 - searching, among the timeslots with priority values (Pi) lower than that of the timeslot (Tx) of the released service (Sx), a timeslot (T) in which at least a communication service having the same number (Rx) of channels (Ci) of the communication service released (Sx) is allocated;
 - 20 - allocating in the timeslot (Tx) of the released communication service (Sx) the communication service (Sy) characterised by the highest attenuation among all the services employing Rx channels (Ci) in the timeslot (T) found with this research.
- 25 8. Method according to the previous claim, characterized in that it includes a release algorithm including the following additional operational steps:
 - searching, among the timeslots with priority values (Pi) lower than that of the timeslot (Tx) of the released communication service (Sx), a timeslot (T) in which at least a communication service employing a number of channels (Ci) lower than that of the communication service released (Sx) is allocated;
 - 30 - allocating in the timeslot (Tx) of the released communication service (Sx) the communication service (Sy) characterised by a higher attenuation amongst all the services employing a number of channels (Ci) lower than that of the communication service released (Sx) and which are allocated in the timeslot (T) found with this search.

9. Method according to claim 7 or 8, characterised in that said algorithm is reiterated starting from the timeslot of the last communication service released (S_y).

10. Method according to one of the previous claims, characterized in that at each allocation and/or release of a service, the priority values (P_i) assigned to the timeslots (T_i) are re-calculated on the basis of the following formula:

$$P_i(k) = \lambda P_i(k-1) + (1-\lambda) s_i(k),$$

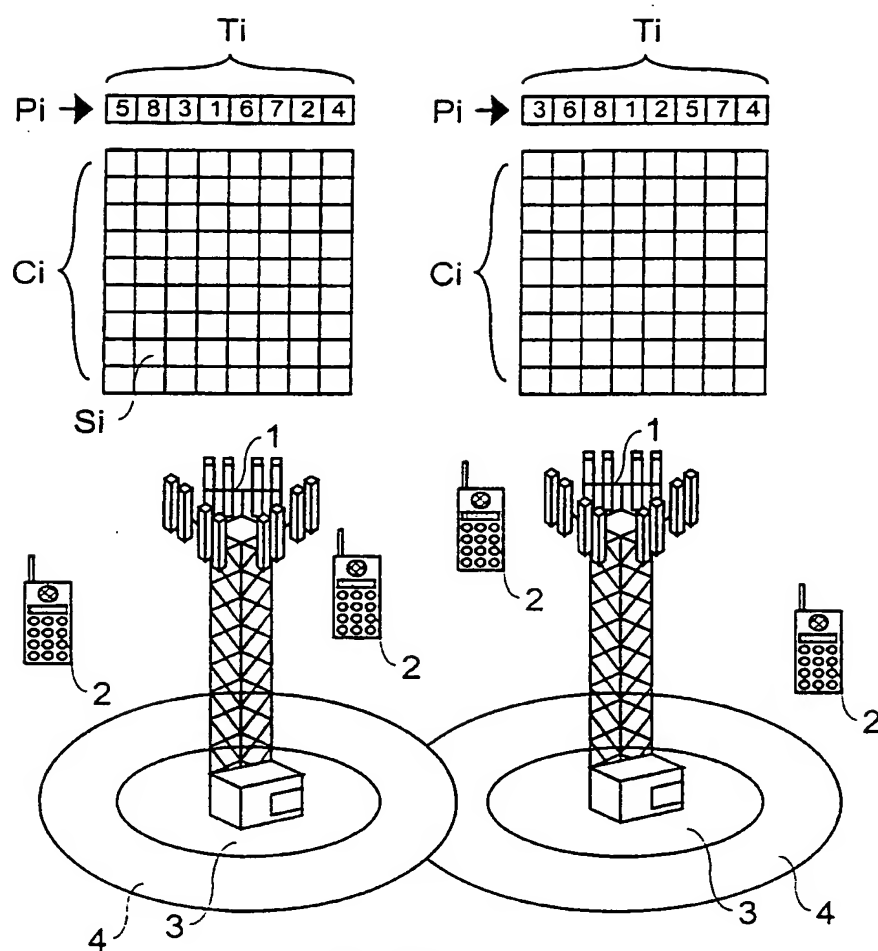
where k is the instant at which the service is allocated or released, $s_i(k)$ is a logic function returning a number between 0 and 1 on the basis of the negative or positive result, respectively, of these requests for connection services and λ is a memory factor included between 0 and 1.

11. Method according to the previous claim, characterized in that $s_i(k)$ is defined by the following formula:

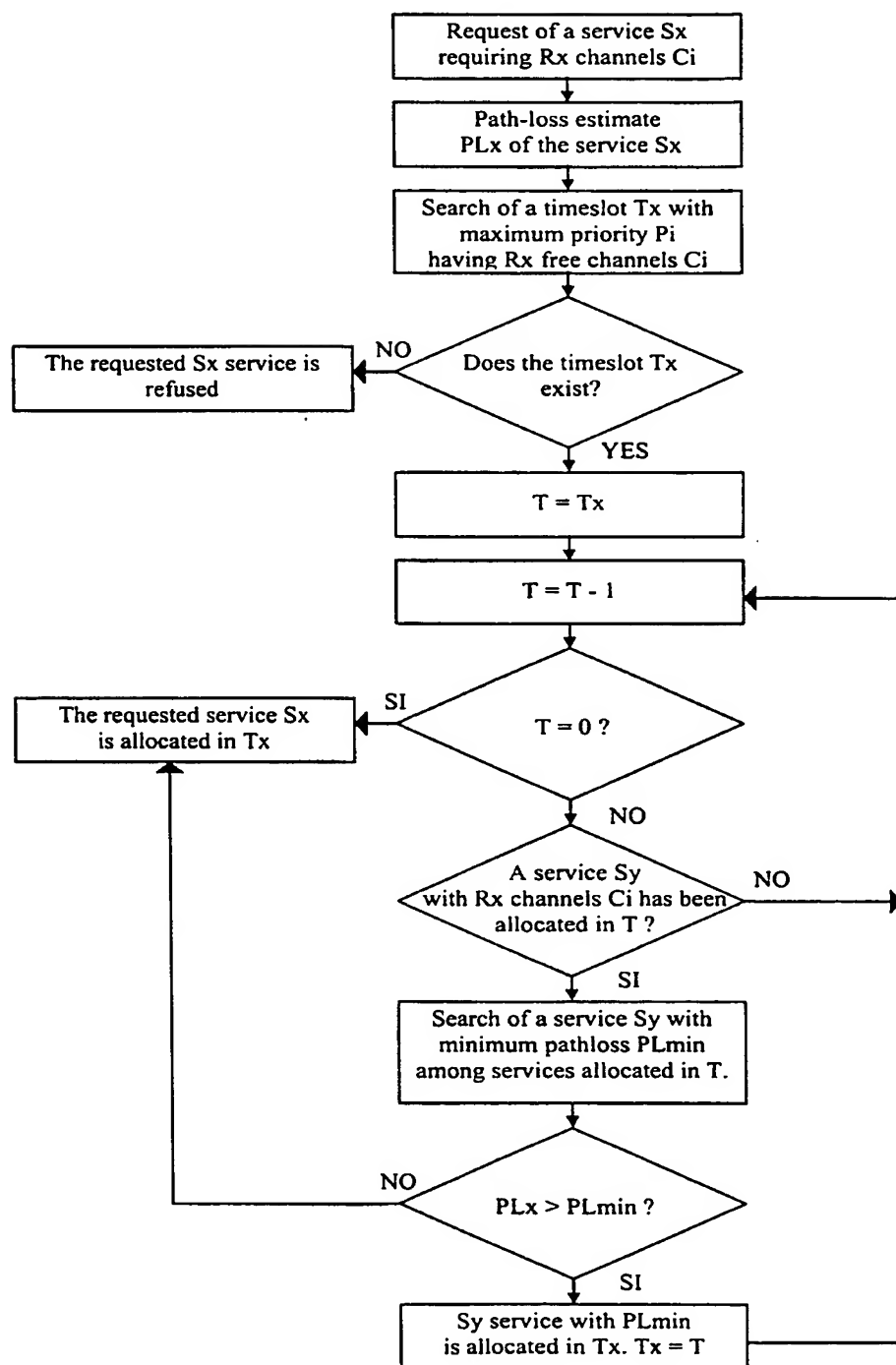
$$s_i(k) = \frac{N_{free_i}(k)}{N_{max} - N_{used_i}(k)};$$

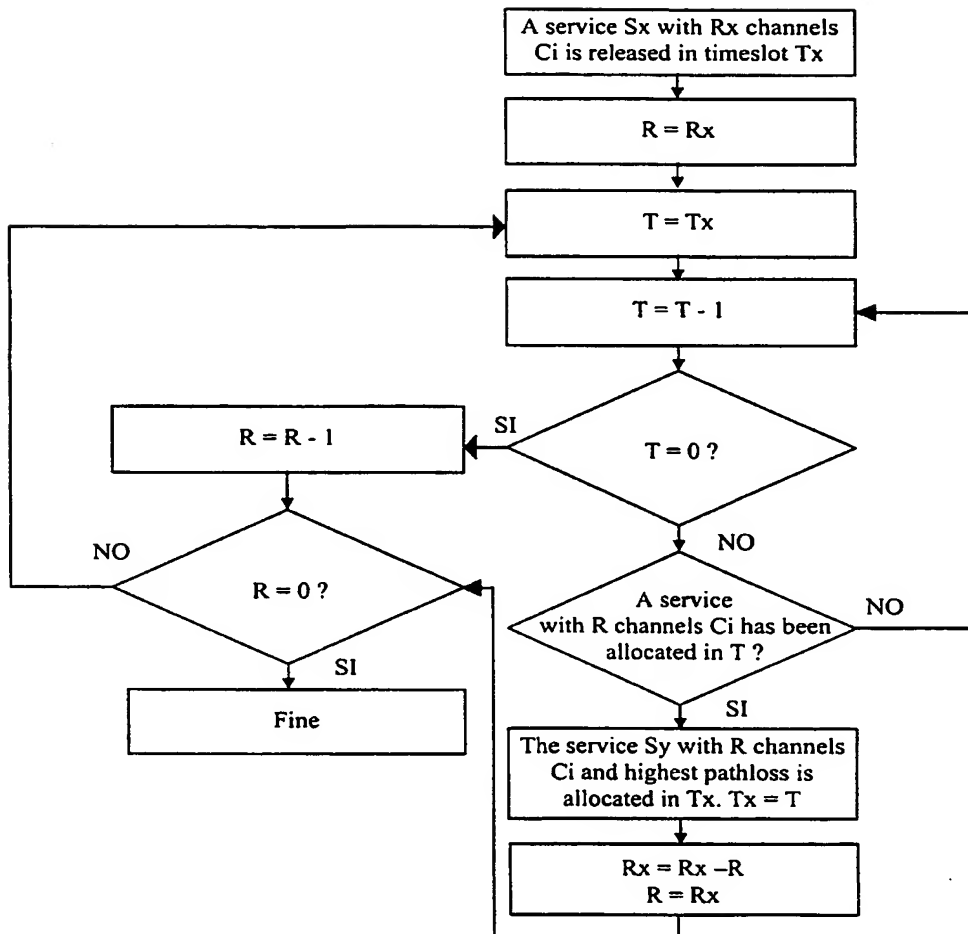
in which $N_{free_i}(k)$ is the number of channels C_i that can be allocated with a good quality in the timeslot i , N_{max} is the maximum number of channels (or codes) available for each timeslot and $N_{used_i}(k)$ is the number of channels presently already allocated in timeslot i .

12. System for the dynamic allocation of radio channels (C_i) in digital telecommunication networks with time division duplex access, in which radio signals are divided in frames having pre-determined duration and each frame is divided into a pre-determined number of timeslots (T_i) which are assigned priority values (P_i) based on interference and/or quality measures of channels (C_i), each communication service (S_x) employing a particular number (R_x) of said channels (C_i) at a time, characterized in that at least one base station (1) for the reception and transmission of radio signals to a plurality of user equipment (2) includes means for the measurement of the path loss (PL_x) of the signal with which said communication service (S_x) has been requested, as well as a control processor suitable to implement the method according to one of the previous claims.

Fig. 1

2/3

**Fig. 2**

Fig. 3

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner
US Department of Commerce
United States Patent and Trademark
Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE
in its capacity as elected Office

Date of mailing (day/month/year) 06 April 2001 (06.04.01)	
International application No. PCT/EP00/07119	Applicant's or agent's file reference DB 782 PCT
International filing date (day/month/year) 24 July 2000 (24.07.00)	Priority date (day/month/year) 30 July 1999 (30.07.99)
Applicant MARGHERITA, Fulvio et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:
08 February 2001 (08.02.01)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was
☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Nestor Santesso Telephone No.: (41-22) 338.83.38
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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

5



Applicant's or agent's file reference DB 782 PCT		FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/EP00/07119	International filing date (day/month/year) 24/07/2000	Priority date (day/month/year) 30/07/1999	
International Patent Classification (IPC) or national classification and IPC H04Q7/36			
Applicant SIEMENS INFORMATION AND COMMUNICATION NETWORKS...			

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 9 sheets, including this cover sheet.
 - ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 14 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☒ Certain observations on the international application

Date of submission of the demand 08/02/2001	Date of completion of this report 19.11.2001
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Jaskolski, J Telephone No. +49 89 2399 7567 

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/EP00/07119

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, pages:

1-7 as received on 25/10/2001 with letter of 25/10/2001

Claims, No.:

1-12 as received on 25/10/2001 with letter of 25/10/2001

Drawings, sheets:

1/4-4/4 as received on 25/10/2001 with letter of 25/10/2001

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/EP00/07119

☐ the drawings, sheets:

5. ☒ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

see separate sheet

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims 2-11
	No:	Claims 1,12
Inventive step (IS)	Yes:	Claims
	No:	Claims 1-12
Industrial applicability (IA)	Yes:	Claims 1-12
	No:	Claims

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Reference is made to the following document:

D1: WO 98 24258 A (TELEFONAKTIEBOLAGET LM ERICSSON) 4 June 1998 (1998-06-04)

Re Item I

1. The amendments filed with the International Bureau under Article 34(2)(b) introduce subject-matter which extends beyond the content of the application as filed, contrary to Article 34(2)(b) PCT. The amendments concerned are the following:
 - a) description page 2, lines 18-21 (sentences from the word "as known" to the word "improved"),
 - b) description page 3, lines 22 to 29 (sentences from the word "the peculiar" to the word "UMTS systems").

Re Item V

1. As far as claim 1 can be understood (see Section VIII, paragraph 1) the claimed invention does not appear to be novel in the sense of Article 33(1) and (2) PCT, because the subject-matter of claim 1 is anticipated by prior art document D1. Document D1 discloses all the features of claim 1, mainly on page 12, lines 10-20 and on page 4, lines 4-25:

Method for [a] dynamic allocation (page 4 line 4: adaptive channel allocation) of radio channels (page 12 line 18: channels are defined) in digital telecommunication networks with time division duplex access (page 12 line 17: time division duplex scheme), the radio channels being associated to radio signals divided into frames (page 12 line 20: frames of the channel) having a pre-determined duration and each frame is divided into a pre-determined number of timeslots (page 12 line 19: time slot T6) which are assigned priority values (page 4 line 13: a table of channels)

based on interference and/or quality measures of channels (page 4 lines 13-14: from the least interfered to the most interfered), each communication service (page 4 line 12: the link) employing a particular number (page 4 line 15: certain number) of said channels at a time, characterized in that [the method] includes the following operational steps:

- measuring the path loss (page 26 line 16: measure levels of multi-path fading; and lines 24-25: indications of the interference and multipath fading) of the [requesting] signal with which said communication service has been requested (page 26 lines 13-14: such measurements may be made responsive to signal levels of signals applied to the measurer 902 by way of a tap 904);
- allocating (page 4 line 12: channels are assigned to the link) said number of channels of the communication service in a timeslot having a priority value increasing with the path loss of the [requesting] signal (page 4 lines 13-14: from the least interfered to the most interfered), in such a way that the [communication] services employing said number of channels are allocated in timeslots having priority values increasing with the path loss of the [corresponding requesting] signal[s] (page 4 lines 24-25: selecting the channel with the highest carrier to interference ratio).

Even if it is not explicitly stated in D1 that the priority value, understood as a place in the table of channels ordered from the least interfered to the most interfered (page 4 lines 13-14: system builds a table of channels), increases with the path loss of the relevant signal, the method of D1, allocating the channels (page 4 lines 24-25: channels are assigned on the basis of selecting the channel with the highest C/i level), on the basis of interference and multipath fading (page 26 line 27) disclosed in the last embodiment of D1, effectively achieves this claimed result.

The subject-matter of claim 1 is therefore not novel.

2. The claimed invention according to claim 12 does not appear to be novel in the sense of Articles 33(1) and (2) PCT, because the subject-matter of **claim 12** is anticipated by a prior art document D1 (references in

parentheses applying to this document):

System (page 8 line 17: telecommunications system) for [a] dynamic allocation (page 27 line 11: channels are dynamically allocated) of radio channels (page 12 line 10: a channel is formed) in digital telecommunication networks with time division duplex access (page 12 line 17: time division duplex scheme), the system including at least one base station (page 24 line 23: base station 852) for the reception and transmission of radio signals associated to the radio channels from/to a plurality of user equipment (page 11 line 21: mobile stations 202 and 206), the radio signals being divided in[to] frames having predetermined duration (page 12 line 19: time slot T6) and each frame being divided into a predetermined number of timeslots (page 12 lines 4-5: each frame is divided into time slots) which are assigned priority values (page 23 line 14: less interfered channel - a more preferred channel) based on interference and/or quality measures of channels (page 18 lines 13-14: link receiver measures C/I on each of the subsets of channels), each communication service (page 16 line 22: communications link) employing a particular number (page 17 line 12: assigning the subset of the at least interfered M channels to the link) of said channels at a time, characterized in that said base station includes means (page 26 line 15: channel condition measurer 902) for the measurement of the path loss (page 26 line 16: measure levels of multi-path fading) of the signal with which said communication service has been requested (page 21 line 5: request messages), as well as a control processor (page 13 line 12: ACA processing portion 360) suitable to implement all the steps of the method according to one of the previous claims (see paragraph 1).

It has been assumed that a position in the table the entries of which are sorted according to claimed interference level (page 4 lines 13-15: system builds a table of channels from the least interfered to the most interfered) corresponds to the feature 'priority value' of claim 12, because in D1 the selection of a channel is made based on this prioritisation (page 4 lines 24-25: channels are assigned on the basis of selecting the channel with the

highest C/i level).

The subject-matter of claim 12 is therefore not novel.

3. As far as dependent **claims 2 to 11** can be understood (see Section VIII for details) the additional features of dependent claims 2 to 11 are either directly derivable from the disclosure provided by the document D1, or a skilled person would select these features, according to circumstances, from the state of the art. Hence none of the features of said dependent claims is suitable, in combination with any claim to which they refer, to establish the required inventive step, dependent claims 2 to 11 do not fulfil the requirements of Article 33(1) and (3) PCT.

Re Item VII

1. Numbering of pages is missing at pages containing drawings.

Re Item VIII

1. **Claim 1** does not meet the requirements of Article 6 PCT in the following:
 - a) **Claim 1** is not supported by the description (Article 6 PCT) as its scope is broader than justified by the description.
 - a1) Claim 1 defines radio channels associated to radio signals only, whereas the description states (page 1, lines 14-19 and page 4, line 23) that the radio channels are assigned to timeslots of frames of the radio signals. No direct association of radio channels to radio signals can be found in the description, therefore the association of the radio channels to radio signals is broader than the disclosure of the invention and thus throws doubt into the scope of protection sought.
 - a2) Claim 1 defines that communication services are allocated in timeslots, thus possibly one service can be allocated in many timeslots, whereas the

description states (page 5, lines 33-36) that the communication service is allocated in one timeslot. No allocations of one service to many timeslots can be found in the description, therefore the allocation of one service to possibly many timeslots is broader than the disclosure of the invention and thus throws doubt into the scope of protection sought.

b) **Claim 1** is unclear (Article 6 PCT) for the following reasons:

b1) Claim 1 defines two types of signals:

- "radio signals" to which radio channels are associated (line 3 of claim 1),
- "the signal" with which said communication service has been requested, i.e. the requesting signal (lines 8-9 of claim 1).

It is therefore unclear, to which one of the above signals the expressions "the signal" (lines 12 and 14 of claim 1) relates.

For the understanding of claim 1 it has been interpreted that "the signal" relates to the second type of signals, and thus is assumed to mean "the requesting signal".

b2) The expression "[communication] services are allocated in timeslots (...) increasing with the path loss of **the [requesting] signal**" (see objection above) is unclear, because claim 1 defines that each communication service is requested by a separate requesting signal (the signal). It is therefore unclear how the plurality of [communication] services is allocated according to one requesting signal. It has been interpreted, according to the description, that this expression should mean "the corresponding requesting signals", indicating a plurality of requesting signals corresponding to plurality of communication services.

b3) By usage of the expression "in such a way" the subject-matter of claim 1 is defined by the result to be achieved, which is unclear (see PCT Preliminary Examination Guidelines Section IV, Chapter III-4.7). It is possible to define the invention in other terms, see in particular the description, page 4, line 33 to page 5, line 2.

2. **Claims 2, 4, 5, 7, and 8** are unclear (Article 6 PCT) in respect to the undefined term "the attenuation". It has been interpreted, according to the description, page 3, line 20, that this term corresponds to the feature "the path loss" of claim 1.
3. It is not clear in **claims 3 and 4** (Article 6 PCT) what is meant by the expression "according to the result of this comparison", because the result of the comparison can be understood as "less", "more" or "equal" and it is not specified in claims 3 and 4 how the expression "according to" relates to these results. It is therefore unclear how the step of allocating in claim 3 and the algorithm reiteration in claim 4 are performed.
4. **Claim 8** as not containing all the features of claim 7 (please refer to Rule 6.4(a) PCT) is not dependent on claim 7. Reference to claim 7 in claim 8 is therefore unclear (Article 6 PCT).
5. **Claim 10** is unclear (Article 6 PCT) because:
 - a) the expression "on the basis of the negative or positive result respectively, of these requests for connection services" is unclear, because it is not previously introduced that the requests produce a result, and how is the result defined.
 - b) the word "instant" in relation to the parameter "k" is unclear.